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SEISMIC PERFORMANCE OF RC BUILDING WITH FLOATING COLUMN

Ayush U. Atkari[1], Neha J. Wani[1], Khushi P. Chavan[1], Lokesh S. Chavan[1], Hritik V. Deshmukh[1], Prof. V. P. Jadhao[2]

[1] UG Student, Government College of Engineering Jalgaon, Opposite Government ITI, National Highway Number 6, Jalgaon, Maharashtra

[2] Assistant Professor, Government College of Engineering Jalgaon, Opposite Government ITI, National Highway Number 6, Jalgaon, Maharashtra

ABSTRACT

A floating column, also known as a hanging or stub column, is a vertical structural element that rests on a beam or slab without direct support from a foundation. Unlike traditional columns that transfer loads directly to the foundation, floating columns act as point loads on the supporting beam, which then transfers the load to the columns below. This design is commonly employed in multi-storey buildings to create open spaces on lower floors, facilitating uses such as parking areas, lobbies, or large halls. The beam supporting the floating column, known as a transfer or girder beam, must be designed to handle the concentrated load, often requiring increased depth and reinforcement. In the present scenario various multistory building are constructed with floating column at various locations for appealing view, for getting more space in parking area for movement and for planning of different plan at different stories. This paper present comparative study about analysis of G + 7 story building with and without floating column at various location within the floors for periphery columns at various levels for seismic zone . The motive of this paper is to compare the response of RC frame buildings with and without floating columns under earthquake loading and under normal loading. This study is to find whether the structure is safe or unsafe with floating column when built in seismically active areas.

KEYWORDS: Floating Column, Multi-Storey Building, ETABS Software, Seismic Zone IV, G+7 Storey, Storey Drift, Bending Moment, Shear Force, Torsion

1. INTRODUCTION

In modern construction, multi-storey buildings often feature open ground storeys to accommodate parking, event lobbies, and other requirements. This design typically involves the use of floating columns, which are structural elements supported at the top but lack direct support below. Floating columns help create unobstructed spaces on lower floors, but they also pose unique challenges in terms of load distribution and structural stability. These columns transfer loads through beams or slabs, rather than directly to the foundation, altering the building's structural behavior. While floating columns offer architectural flexibility and aesthetic benefits, they can introduce vulnerabilities, such as increased shear, bending, and torsion stresses.

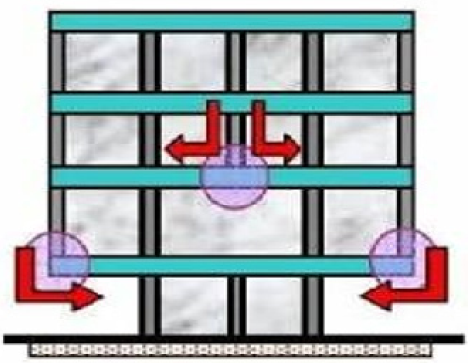

Fig 1.1. Floating Column

This research aims to evaluate the performance of multi-storey structures with floating columns, specifically under earthquake excitations. The study will explore the structural safety, identify critical positions for floating columns, and compare key parameters like displacement, story drift, shear force, and bending moments in buildings with and without floating columns.

2. LITERATURE REVIEW

Harsha P.V. and Shilpa Valsakumar analyzed G+10 storey normal and floating column structures under seismic forces, focusing on safety in seismic Zone III and the optimal floating column position. Kishalay Maitra

and N.H.M. Kamrujjaman Serker compared the seismic performance of floating column and normal structures, showing a 56.96% increase in displacement with floating columns. Gaurav Pandey and Sagar Jamle studied G+14 storey structures with floating columns, finding that top-story placement yielded the best performance under seismic load. Sreadha A.R. and C. Pany reviewed the behavior of structures with and without floating columns using ETABS, focusing on seismic areas. Sreekanth Gandla Nanabala, Pradeep Kumar Ramancharla, and Arunakanthi E compared G+5 storey structures with and without edge columns, noting the redistribution of load to interior columns.

3. METHODOLOGY

A G+7 storied model of building is analyzed having 5 bays in x direction and 5 bays in z direction for a normal building with and without floating column at various locations within the floor level and in different stories.

Number of storey	G+7
Storey height	3m
Utility of the building	Residential
Grade of concrete	M30
Grade of steel	HYSD415
Beam size	(300*600) mm
Column size	(600*600) mm
Slab thickness	150mm
Number of grid lines along X-direction	6
Number of grid lines along Y-direction	6
Bay width along X-direction	5
Bay width along Y-direction	5
Seismic zone	IV
Soil type	Medium soil

Table 3.1: Building Data

Modelling of different positions of floating column are as follow:

Model 1: Normal Building .

Model 2: Floating column provided at four columns of the building and inside the building.

Model 3: Floatimg column provided at parallel position .

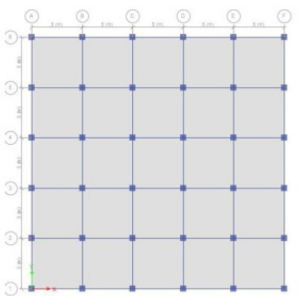

Fig 3.1 Model 1

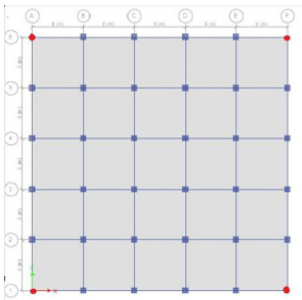

Fig 3.2 Model 2

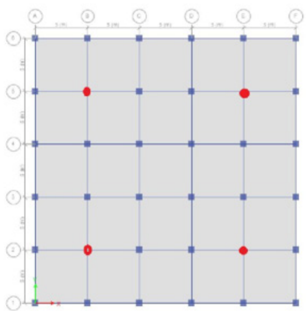

Fig 3.3 Model 3

4. RESULTS OF ANALYSIS

4.1 Comparison of steel reinforcement between normal building and building with floating columns.

Modelling of structure	Model 1	Model 2	Model 3
Steel reinforcement required (mm^2)	2880	4683	2454
% Change in steel	-	62.60	-14.79

Table 4.1: % change in Steel reinforcement for columns

Modelling of structure	Model 1	Model 2	Model 3
Steel reinforcement required (mm^2)	2880	2392	4683
% Change in steel	-	-16.94	62.6

Table 4.2: % change in Steel reinforcement for beams

4.2 Comparison of shear force and bending moment between normal building and building with floating columns.

Modelling of structure	Model 1	Model 2	Model 3
Shear Force (KN)	-93.9104	-61.3025	121.71
Bending Moment (KN- M)	-137.7107	-105.559	156.2455
%Change in SF	-	-34.72	29.60
% Change in BM	-	-23.34	13.45

Table 4.3: % Change in Shear Force and Bending Moment for columns

Modelling of structure	Model 1	Model 2	Model 3
Shear Force (KN)	-60.48	-197.4957	-211.0126
Bending Moment (KN- M)	-38.1275	-321.4643	-283.8256
%Change in SF	-	226.54	248.89
%Change in BM	-	743.129	644.411

Table 4.4: % Change in Shear Force and Bending Moment for beams

4.3 Comparison of torsion (for columns) between normal building and building with floating columns.

Modelling of structure	Model 1	Model 2	Model 3
Torsion (Kn-m)	-0.0493	0.3851	-0.0574
% Change in Torsion	-	681.13	16.43

Table 4.5: % change in Torsion for columns

4.4 Comparison of torsion (for beams) between normal building and building with floating columns.

Modelling of structure	Model 1	Model 2	Model 3
Torsion (Kn-m)	-0.0209	-4.2121	-0.0352
% Change in Torsion	-	2568.04	68.42

Table 4.6: % change in Torsion for beams

4.5 Comparison of story drift between normal building and building with floating columns.

Model 1		Model 2		Model 3	
Elevation (m)	Storey drift (mm)	Elevation (m)	Storey drift (mm)	Elevation (m)	Storey drift (mm)
0	0	0	0	0	0
2	0.000281	2	0.000355	2	0.000282
5	0.000585	5	0.000651	5	0.000707
8	0.000618	8	0.000634	8	0.000709
11	0.000611	11	0.00062	11	0.00071
14	0.000583	14	0.000591	14	0.000675
17	0.000534	17	0.000542	17	0.00061
20	0.000457	20	0.000468	20	0.000514
23	0.00035	23	0.000365	23	0.000386
26	0.000218	26	0.000249	26	0.000241

Table 4.7: Data of Story Drift for various stories

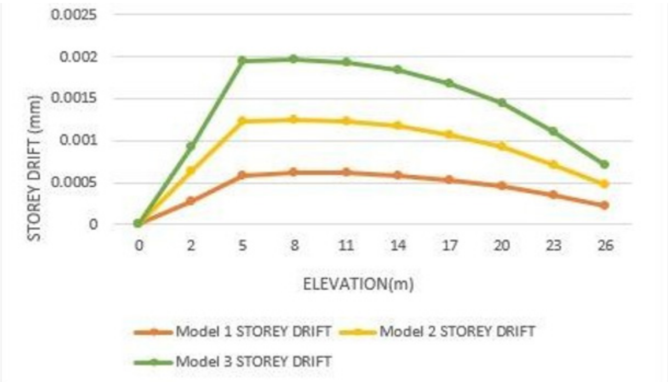

Chart 4.1 Comparison of story drift

4.6 Comparison of story displacement between normal building and building with floating columns.

Model 1		Model 2		Model 3	
Elevation (m)	Storey drift (mm)	Elevation (m)	Storey drift (mm)	Elevation (m)	Storey drift (mm)
0	0	0	0	0	0
2	0.562	2	0.794	2	0.565
5	2.282	5	2.469	5	2.449
8	4.135	8	4.337	8	4.574
11	5.968	11	6.196	11	6.703
14	7.718	14	7.968	14	8.727
17	9.319	17	9.592	17	10.557
20	10.69	20	10.993	20	12.099
23	11.739	23	12.089	23	13.257
26	12.394	26	12.825	26	13.98

Table 4.8 Data of Story Displacement for various stories

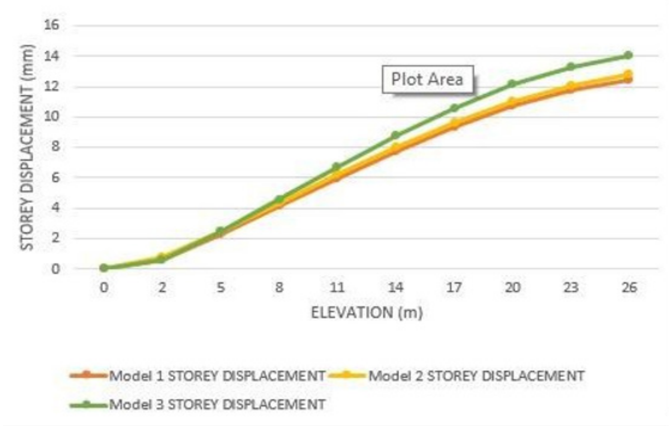

Chart 4.2 Comparison of story displacement

5. CONCLUSION

1. As per Clause 7.1, Table 6 (vi) of IS 1893 (Part 1):2016, floating or stub columns are likely to cause concentrated damage in the structure. Such features are considered undesirable and should be avoided, particularly when they form part of, or support, the primary lateral load-resisting system. However, due to specific client requirements, the inclusion of floating columns in the building design has become necessary.

2. The results of the structural analysis indicate that the construction of a building with floating columns is feasible, subject to the implementation of appropriate design considerations to ensure structural safety and compliance with relevant codes.

3. The results of the analysis indicate a significant variation in steel consumption due to the inclusion of floating columns. Specifically, for Model 2 (refer Tables 4.1 and 4.2), the percentage increase in steel for columns is 62.60% compared to Model 1, while the percentage decrease in steel for beams is 16.94%. In contrast, for Model 3, there is a 14.79% decrease in steel for columns and a 62.60% increase in steel for beams compared to Model 1. These variations result in an overall increase in material usage, making the structure less economical. However, if the owner is willing to proceed despite the increased cost implications, the structure can be constructed, provided all safety and code compliance measures are thoroughly addressed.

4. The study of floating columns in building structures has enhanced the engineer's understanding of their behavior, design implications, and impact on overall structural performance. It is essential that engineers possess adequate knowledge of floating column behavior and its consequences, especially in seismic zones. The analysis was conducted in accordance with relevant IS codes, including IS 1893 (Part 1):2016 and IS 456:2000, ensuring compliance with safety and design standards. Although floating columns may result in higher construction costs, they can be adopted when architecturally required, provided appropriate structural measures are taken.

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